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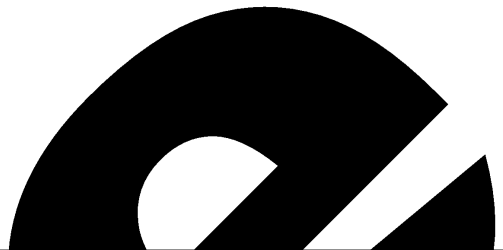

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DIRECTORATE OF
INTELLIGENCE

Intelligence Memorandum

The Chemical Fertilizer Industry in Communist China in 1971

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November 1971

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CENTRAL INTELLIGENCE AGENCY
Directorate of Intelligence
November 1971

INTELLIGENCE MEMORANDUM

THE CHEMICAL FERTILIZER INDUSTRY IN COMMUNIST CHINA IN 1971

Conclusions

1. Production of chemical fertilizers in Communist China in 1971 is expected to reach a record high of 9.6 million tons,[1] a 30% gain over 1970 and almost twice the level of 1966. The total supply is also expected to reach a new high of almost 14 million tons, with imports remaining at about the 1970 level of 4.3 million tons.

2. The growth in the supply of chemical fertilizers reflects the regime's continued emphasis on the support of agriculture with industrial inputs, a policy first put into effect in 1962 after the "disaster years" of 1959-61. Nonetheless, the quantity available is still less than half of the 35 million tons that could be profitably used by agriculture each year under existing technological conditions. On a nutrient basis, China applies only one-tenth of the fertilizer per hectare applied by West European countries and Japan. On the other hand, China compares favorably with the developing countries, such as India, which import much of their chemical fertilizer.

3. The swift growth of China's chemical fertilizer production has been constrained by the expanded requirements for chemical processing capacity and for additional supplies of coal, a major feedstock. To ease these constraints, the government has moved energetically to build hundreds of local chemical fertilizer plants of a lower but adequate technology and to build a number of large modern plants that are beginning to make greater use of natural gas and petroleum as raw materials.

1. Tonnages are given in metric tons throughout this memorandum.

Note: This memorandum was prepared by the Office of Economic Research.

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4. The most pronounced feature of the chemical fertilizer industry in the last three years has been the rapid development of large urea fertilizer plants each producing about 40,000 tons per year. Urea fertilizer is cheapest to produce and contains the highest nutrient content of all the other nitrogen fertilizers. China is believed to now have several urea plants on-stream with others under construction.

5. Prospects for increasing the supply of fertilizer in the remaining years of the Fourth Five-Year Plan (1971-75) are favorable. By 1975, China with great effort could double the 9.6 million ton output expected in 1971 to 20 million tons. In the meantime, China will take advantage of low international prices and will remain the world's largest importer of chemical fertilizers. Technical assistance for the domestic industry will continue to come from Japan and Western Europe.

Discussion

Introduction

6. After the three "disaster years" in agriculture, 1959-61, the Chinese Communist leadership adopted a new policy of support for the agricultural sector by greatly stepping up inputs of chemical fertilizer, pesticides, pumps, and other equipment. These new inputs, along with generally favorable weather, have enabled agricultural output to keep abreast of the huge and rapidly growing population since 1962. This memorandum surveys recent developments in China's chemical fertilizer industry, provides estimates of domestic production and imports of chemical fertilizers, and examines prospects for the industry in the Fourth Five-Year Plan (1971-75). Emphasis is placed on the expansion of domestic productive capacity and on certain technical problems of the industry.

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7. The chemical fertilizer industry of Communist China continues to be marked by wide differences in the scale of production and in the kinds and quality of output. Large enterprises under control of the central government produce a variety of products of good quality and remain the backbone of the industry. Small factories under local control also contribute substantial amounts of output which, while not up to Western standards, play a useful part in Chinese agriculture. The policy of the regime is to expand both types of plants rapidly. Nevertheless, China's

ability to supply the huge amounts of fertilizer required now and in the future will be determined mainly by the regime's success in developing production at large plants. The discussion below deals not only with the question of plant size but also with the distinctions among the basic types of chemical fertilizers.(2)

Nitrogen Fertilizer Production at Large Plants

8. The production of nitrogen fertilizer in Western countries is generally based on natural gas or petroleum whereas the Chinese continue to use the older method based on coal. Recent press comments now indicate that at several large fertilizer plants the Chinese have begun to use waste gas from petroleum refineries and steel mills. One possible method of reducing production costs and easing the demand for raw materials would be to exchange byproducts between plants as in Figure 1. In addition to the use of waste gases, Chinese plants are expected in the future to make direct use of petroleum as the domestic supplies increase. While the Chinese chemical fertilizer industry will remain primarily based on coal as a feedstock for some time to come, the use of petroleum and waste gas for feedstocks is increasing. For the locations of fertilizer plants in China, see Figure 2.

9. The increased demand for coal throughout the economy is a constraint on the increase of chemical fertilizer production.(3) Large-plants for many years have experimented with using low-grade coal and coal dust to produce fertilizer. Fukien Province had, for example, depended on lump coal from other provinces. Now the use of briquettes, made from low-grade coal, meets 70% of the provincial requirements for chemical fertilizer production.

10. Problems in the design and production of major equipment for fertilizer plants also has held back the expansion of output. The high pressures, temperatures, and caustic materials involved in fertilizer production have caused serious delays in attempts to scale up experimental plants. For many years, the Chinese had considerable difficulty in developing urea processes, specifically in constructing and operating urea prilling

2. Chemical fertilizers are of three basic types each providing crops with a different nutrient: nitrogen (N); phosphorus (P); and potassium (K). The Chinese have emphasized the production of nitrogen fertilizer because the soil is generally deficient in this element. Nitrogen fertilizers such as ammonium nitrate, ammonium sulfate, and urea require synthetic ammonia in large quantities for production. Phosphorus fertilizer is made from crushed phosphate rock processed at high temperatures or with acid. Potassium fertilizers are obtained by refining potash deposits.

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Figure 1

Flow Diagram of By-Product Exchange

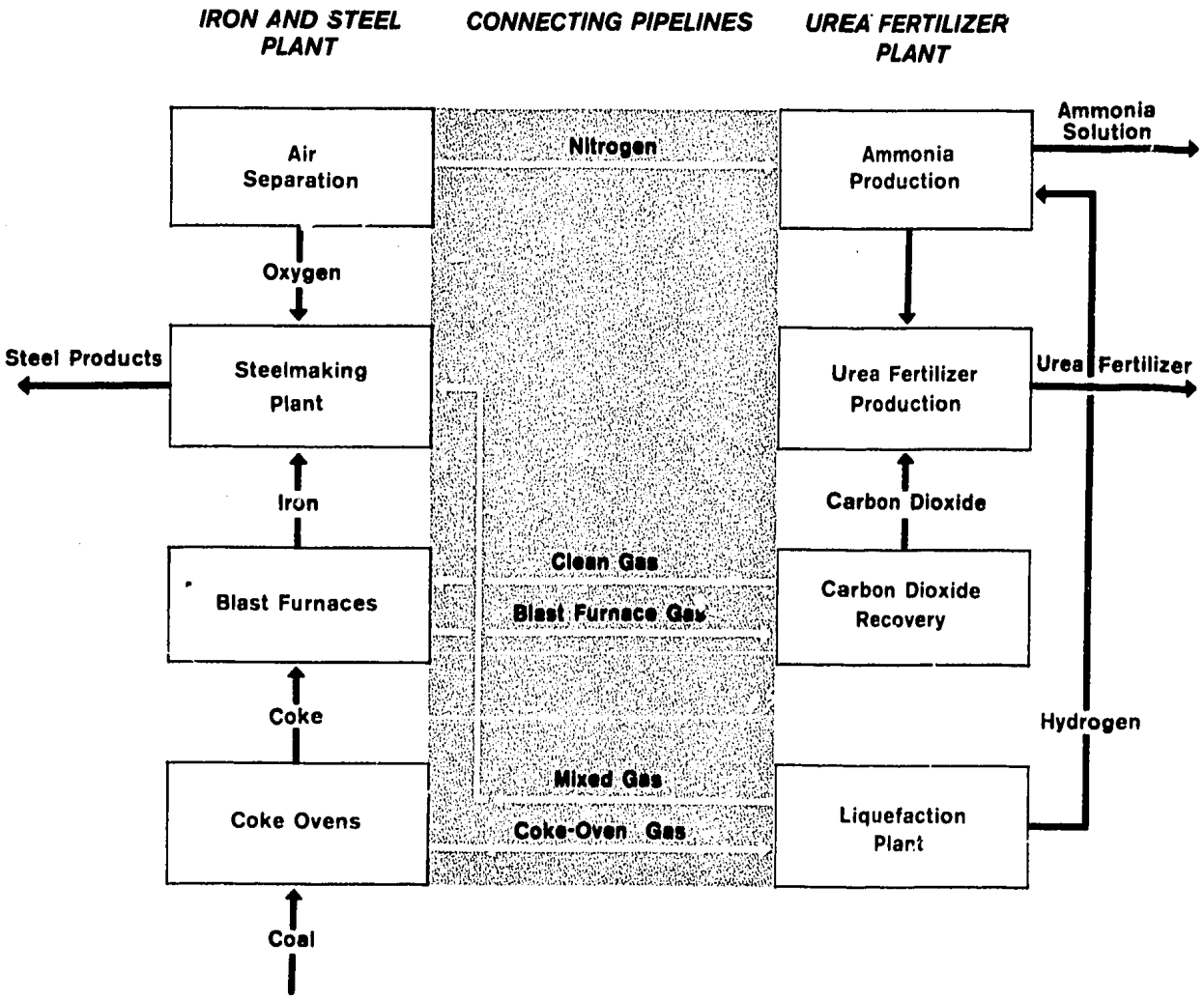

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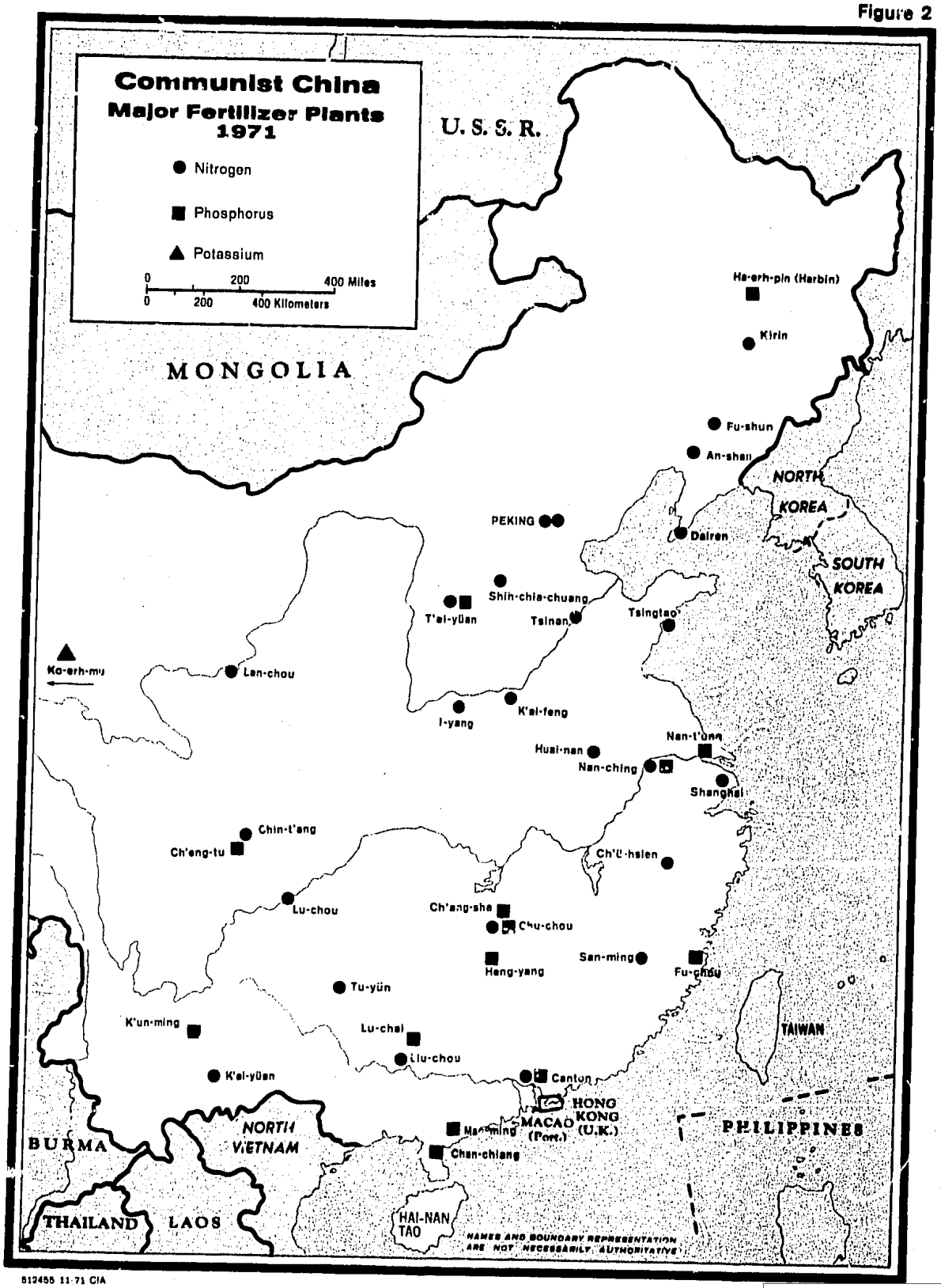
Figure 2



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towers.[4] The problem was sidestepped for a time by producing urea crystals.

11. An important contribution to upgrading Chinese technology was the purchase of the large Lu-chou urea complex from the British and Dutch in 1963. This urea complex, which was taken apart piece-by-piece upon arrival in China, embodied technical know-how needed by the Chinese for their domestic plants. Since that time the Chinese have been able to construct several new urea plants, all of which have prilling towers. The Lan-chou Petrochemical Machinery Works reportedly went into serial production of urea prilling towers in early 1970 (see Figure 3). These towers

Figure 3. Serial production of urea prilling towers at the Lan-chou Petrochemical Machinery Works.

are constructed of high strength, low-alloy steel entirely made in China. The new urea plants are of standardized design, each with an annual capacity of 40,000 tons per year, or about one-tenth the size of the larger urea plants now being built in the West. The standardized design will permit the Chinese to pool spare parts, mass produce equipment, exchange operating data, and check efficiency between plants.

4. A prilling tower is used to process urea into small solid pellets called prills. The urea is sprayed out at the top of a high tower to fall through a hot rising air mass and forms prills. In this form the urea is easier to apply to the soil and is less likely to be carried away by the wind. Urea crystals are simply formed by evaporation and do not require the construction of a prilling tower.

12. China began production of urea fertilizer in 1965. The annual output of urea at that time was around 15,000 tons per year. Chinese success in developing urea processing technology has meant a continued construction of urea facilities and an increase in the output of urea to more than 400,000 tons in 1970. The high priority given to urea production by the planners stems from the fact that urea contains the highest amount of plant nutrient of all the fertilizers available (approximately 46% N) and is the cheapest to produce. It is also easier to store, transport, and apply -- important considerations given the conditions in the agricultural sector.

Small Nitrogen Fertilizer Plants

13. More than five years have passed since the first small-scale chemical fertilizer plants went into operation. Peking now should be able to assess their worth. In 1969 it was claimed that on the average a small chemical fertilizer plant took only 2.5% of the fixed investment required by a large plant but had a production capacity of 4.5% of the large plants. The small plants reportedly can be set up in one-third of the time using local materials (see Figure 4). In general, Peking seems to have accepted the small plants as a feasible way of conserving on resources in short supply and of better using the huge underemployed labor force.

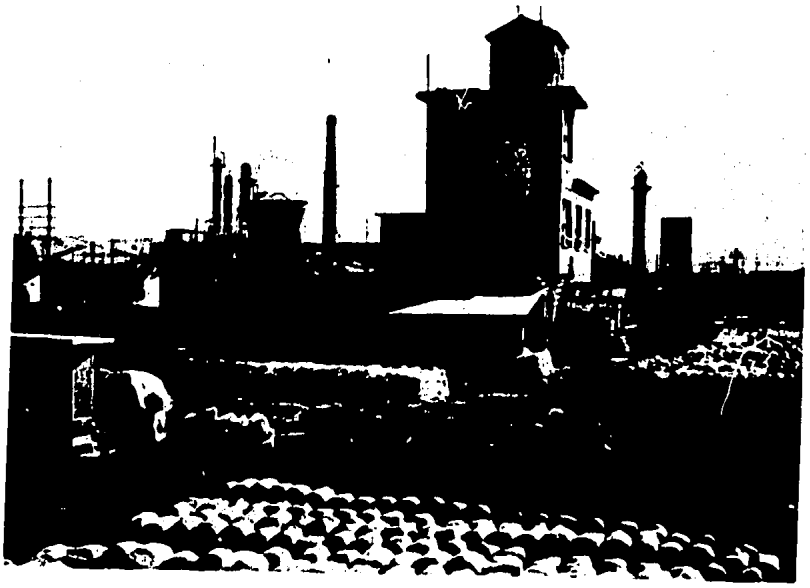

Figure 4. Parallel with the establishment of large chemical fertilizer plants, China has built small works. The photograph shows nitrogen fertilizer turned out by a county-run plant ready for shipment to rural communes. Note open storage of finished products.

14. Kiangsu Province is an example of the application of the policy of developing small chemical fertilizer plants simultaneously with large plants. This province lies astride the Yangtze River delta, one of China's major grain and cotton growing areas. According to Chinese press reports, 57 small chemical fertilizer plants have been completed in the province and 15 more are expected to go into operation before the end of 1971. The amount of chemical fertilizer applied to each hectare of farmland in the province in 1970 was four times that of 1965. Formerly, Kiangsu had depended entirely on the state for the supply of chemical fertilizer, but locally produced chemical fertilizer now is said to account for 60% of the total applied in the province. More than half the funds for the small chemical fertilizer plants in the province were raised locally and more than half of the equipment was produced by local plants. While the emphasis is on a bootstrap effort, complete equipment manufacture for small, modern nitrogen plants is clearly beyond the capacity of lower administrative units. Thus, Shanghai with its modern machine building facilities provided equipment for such units. These small coal-fed fertilizer plants are miniature "modern" plants which employ 250 to 350 workers and produce 3,000 to 5,000 tons of fertilizer a year.

15. Workers from all over China have been trained at Shanghai to staff and operate small chemical fertilizer plants. Much equipment, material, and technical know-how must be provided by the developed sector so that the small plant program does make certain demands on centrally controlled resources. Presumably, the planners in Peking believe that many of these remaining costs can ultimately be pushed down to the local level.

16. The regime has claimed that output of small plants in 1970 accounted for 43% of all nitrogen fertilizer produced. This reporting is believed to be in terms of product weight which overstates the importance of the small plants relative to large plants. The small plants produce no more than 35% of the nitrogen fertilizer, expressed in terms of nutrient content.

17. Some of the products of the small nitrogen fertilizer plants, such as ammonium bicarbonate and ammonia water, are helpful to crops but have inherent shortcomings and are not in common use in other countries. Both of these products decompose easily when stored or exposed to the weather for any length of time. A complex and efficient distribution apparatus is needed to get the product to the farm gate at the right time, particulary since demand is seasonal. The small plants are a useful complement to the large plants. The production and distribution of the varying kinds of fertilizer, of course, must be dovetailed with the growing season to help maximize their effectiveness. Reports from China indicate that this is somewhat of a problem because of the transportation burden; however, at least a rough measure of success is now being achieved.

Phosphorus and Potassium Fertilizer

18. China has extensive phosphorus deposits, but most of these deposits are average or low grade. Phosphate fertilizer production has not been emphasized until recently in China; in general, the required mix of fertilizers has been such that increased nitrogen fertilizer would have greatly raised yields whereas more phosphorus fertilizer would have had much less impact at the margin. The low grade of phosphate ore has also held back production despite the fact that the equipment needed for setting up phosphate plants is simpler and less costly than that required for small nitrogen plants. China imports large quantities of high-grade phosphate ore to be processed by domestic plants. Production of phosphate fertilizers requires only that finely ground phosphate rock be treated with high temperatures or acids so that the plant nutrient, phosphorus pentoxide (P_2O_5), be available for plants. The high-temperature method is favored in China since it can use local coal and conserve on acids – in particular, sulfuric acid which is chronically in short supply. Output of phosphate fertilizer currently is increasing, especially from numerous small plants in Yunnan, Kwangtung, and Kwangsi. Because of the absense of strict operating controls at these small plants, however, a sizable amount of raw phosphate ore is crushed and tagged as chemical fertilizer without going through the more rigid method of being treated at high temperatures.

19. Chinese production of potassium fertilizer remains small since the soil generally has sufficient potassium content. The use of potassium in the form of mixed or compound fertilizer is expected to increase as the soil becomes depleted by continued cultivation using only nitrogen and phosphorus fertilizers. The extensive potash deposits in the Tsaidam and Tarim Basins in extreme western China are more than sufficient to meet China's needs. Some expansion of the Ko-erh-mu Potassium Fertilizer Plant in Tsinghai Province has taken place. Potash is obtained from salt lakes in these areas by a series of evaporative fields which use little mechanical assistance. Production is believed to be in the neighborhood of 50,000 tons per year, with this output being shipped to the agricultural regions in the east. The lack of transportation facilities to the agricultural areas handicaps the more rapid expansion of output of potassium fertilizer.

Estimated Production of Chemical Fertilizer

20. Domestic production of chemical fertilizer in 1971 is at a record high and, for the first time in recent years, is expected to exceed amounts imported in terms of both product weight and nutrient content. Output for 1971 is estimated at 9.6 million tons, up 2 million tons from 1970. Table 1 gives domestic production of chemical fertilizer by type.

Table 1

Estimated Production of Chemical Fertilizers a/

Thousand Metric Tons

	Total		Nitrogen		Phosphorus		Potassium	
Year	Product Weight	Nutrient Weight	Product Weight	Nutrient Weight	Product Weight	Nutrient Weight	Product Weight	Nutrient Weight
1952	194	39	194	39	0	0	0	0
1957	803	159	683	137	120	22	0	0
1958	1,354	266	1,010	202	344	64	Negl.	Negl.
1959	1,900	380	1,360	270	500	95	40	15
1960	2,500	495	1,680	335	000	150	20	10
1961	1,400	275	995	200	400	75	5	Negl.
1962	2,100	410	1,500	300	600	110	Negl.	Negl.
1963	2,900	570	2,000	400	900	170	Negl.	Negl.
1964	3,500	685	2,300	460	1,200	225	Negl.	Negl.
1965	4,500	880	3,000	600	1,500	280	Negl.	Negl.
1966	5,500	1,075	3,700	740	1,800	335	Negl.	Negl.
1967	4,000	780	2,600	520	1,400	260	Negl.	Negl.
1968	4,800	940	3,200	640	1,600	300	Negl.	Negl.
1969	5,800	1,135	4,000	800	1,800	335	Negl.	Negl.
1970	7,420	1,460	5,100	1,020	2,300	430	20	10
1971	9,650	1,900	6,400	1,280	3,200	600	50	20

a. Product weight of various types of chemical fertilizer is given after conversion to Chinese "standard fertilizer units" of fixed nutrient content: nitrogen fertilizers in terms of 20% N; phosphorus fertilizers of 18.7% P_2O_5; and potassium fertilizer of 40% K_2O. Untreated phosphate rock is not included as chemical fertilizer. Data for 1952, 1957, and 1958 were reported by Communist China. Data for 1959 through 1971 are estimates rounded to the nearest 5,000 metric tons.

Regional Expansion of the Industry

21. In 1949 the output of chemical fertilizer in China was centered at two major plants, one in Dairen and the other in Nan-ching. Both plants were designed and built prior to World War II. Since that time the industry has expanded rapidly – with Soviet assistance in the 1950s but mainly through the efforts of the Chinese themselves. By 1970, chemical fertilizer plants had been located in the major agricultural regions (see Table 2). No province now produces more than 15% of the national chemical fertilizer output. This development has been especially rapid in the Central-South economic region (Honan, Hupeh, Hunan, Kwangtung, and Kwangsi) where output has nearly tripled in the past five years.

Table 2

Regional Growth
of Chemical Fertilizer Production a/

Thousand Metric Tons

	1952	1957	1965	1970
Total output	*194*	*803*	*4,500*	*7,420*
Northeast	131	463	930	1,100
East	63	300	1,310	1,970
North	-	-	630	950
Central-South	-	20	670	1,900
Southwest	-	20	660	1,000
Northwest	-	-	300	500

a. See the footnote to Table 1.

Imports

22. While domestic production has increased rapidly, imported fertilizer still remains an important portion of total supply. [redacted] 25X1

25X1 [redacted] imports in 1971 will be about 4.3 million tons, the same level as last year. This will then give China a total supply of 14 million tons (product weight) of chemical

fertilizer, up from 12 million tons for 1970. Despite this growth in supply, China's consumption of chemical fertilizer still remains low in comparison to that of other countries. The amount of fertilizer nutrient available to China per hectare of sown area averaged only about 13 kilograms in 1967, 17 kilograms in 1969, and a projected 22 kilograms for 1971. Japan's consumption was 275 kilograms of nutrient per hectare over the 1967/68 fertilizer year. China can greatly increase its fertilizer application rates and obtain a higher crop yield to support the population. Population growth alone requires an increase of 4 million tons of grain just to maintain the present living levels.(5)

Prospects

23. China has now recovered the rhythm of industrial growth lost during the Cultural Revolution. Premier Chou En-lai told the American journalist Edgar Snow that production of chemical fertilizer for 1970 was approximately 14 million tons. Chou further indicated that China needed a minimum of 30 million to 35 million tons of chemical fertilizer annually for agriculture. If this is the production goal for 1975 -- the last year of the new Fourth Five-Year Plan -- the fertilizer industry would indeed have been raised to a starring role.

24. The production figure given by Chou for chemical fertilizer is double the estimate given for 1970 in this memorandum. The figure given by Chou probably is not comparable. For one thing, it may exaggerate output by the inclusion of many products which are not chemical fertilizers at all. The output of crushed phosphate rock does help crops but not nearly so effectively as chemically treated and processed phosphate. In addition, the figures may include the processing of waste and sludge collected for use as chemical fertilizer on farmland. Furthermore, the statistical reporting system in a "command economy" has a strong upward bias which may be particularly operative in this kind of economic activity. In the case of chemical fertilizers, this bias mainly occurs at lower levels such as small plants where administrative controls are not as strict. At larger plants, standards are usually maintained and statistical data are more reliable. Finally, nutrient content of one unit of weight of chemical fertilizer from a small plant is likely to be less than that produced at a larger plant. In short, Chou's numbers appear much too high to be accepted.

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5. For the estimated total supply of chemical fertilizer – domestic production plus imports on a product weight and nutrient content basis – for the period 1957-71, see the Appendix.

25. Peking is unlikely to be able to produce 30 million to 35 million tons of chemical fertilizer by 1975, even using Chou's 1970 figure of 14 million tons. To meet such a goal, China would be required to construct at least 25 large chemical fertilizer plants each year for five years. At the present time, there are no indications that this is occurring. Present evidence suggests that China will be fortunate to produce 20 million tons by 1975. In the short-run, China will remain the world's largest import market for fertilizer. Self-sufficiency would seem to require another decade of development. Meanwhile, international fertilizer prices remain low because of an optimistic forward building of capacity by major suppliers and thus are to China's advantage.

26. The future growth in domestic production is likely to require increased imports of whole plants as well as key equipment, special steels, and technology. In particular, the regime probably will be interested in importing large plants for the production of nitrogen fertilizer, especially urea. In July 1971, [redacted] the Chinese 25X1
25X1 were interested in the purchase of a complete plant for the production of nitrogen fertilizer, with a price offer expected before the end of 1971.

25X1 [redacted] Even if contracts are signed before the end of 1971, it is unlikely that such plants could be commissioned by 1974. Thus, imports of large chemical fertilizer plants will have no short-term impact on China's dependence on imported fertilizer.

27. Future Chinese aid to developing countries may include small chemical fertilizer plants. Pakistan is reported to expect Chinese assistance in the construction of a urea plant, which is believed will produce about 40,000 tons of urea per year.(6) If this plant is built, it will likely be of standard Chinese design and will be a testimonial to confidence in their own technical capabilities.

6. The reported figure was 80,000 to 90,000 tons per year, which is believed to be in terms of ammonium sulfate fertilizer.

APPENDIX

Communist China: Production, Imports, and Supply of Chemical Fertilizer a/

Thousand Metric Tons

Year	Supply				Production b/				Imports c/			
	Total	Nitrogen	Phosphorus	Potassium	Total	Nitrogen	Phosphorus	Potassium	Total	Nitrogen	Phosphorus	Potassium
1957	1,930 (430)	1,640 (370)	270 (50)	20 (10)	803 (159)	683 (137)	120 (22)	0 (0)	1,130 (270)	960 (230)	150 (30)	20 (10)
1958	2,970 (625)	2,580 (550)	390 (75)	Negl. (Negl.)	1,354 (266)	1,010 (202)	344 (64)	Negl. (Negl.)	1,620 (360)	1,570 (350)	50 (10)	0 (0)
1959	3,080 (650)	2,530 (540)	510 (95)	40 (15)	1,900 (380)	1,360 (270)	500 (95)	40 (15)	1,180 (270)	1,170 (270)	10 (Negl.)	0 (0)
1960	3,490 (710)	2,650 (545)	820 (155)	20 (10)	2,500 (495)	1,680 (335)	800 (150)	20 (10)	990 (215)	970 (210)	20 (5)	0 (0)
1961	2,440 (500)	2,035 (425)	400 (75)	5 (Negl.)	1,400 (275)	995 (200)	400 (75)	5 (Negl.)	1,040 (225)	1,040 (225)	Negl. (Negl.)	0 (0)
1962	3,140 (650)	2,540 (540)	600 (110)	Negl. (Negl.)	2,100 (410)	1,500 (300)	600 (110)	Negl. (Negl.)	1,040 (240)	1,040 (240)	0 (0)	0 (0)
1963	4,860 (1,110)	3,960 (940)	900 (170)	Negl. (Negl.)	2,900 (570)	2,000 (400)	900 (170)	Negl. (Negl.)	1,960 (540)	1,960 (540)	Negl. (Negl.)	0 (0)
1964	4,720 (1,045)	3,340 (785)	1,380 (260)	Negl. (Negl.)	3,500 (685)	2,300 (460)	1,200 (225)	Negl. (Negl.)	1,220 (360)	1,040 (325)	180 (35)	Negl. (Negl.)
1965	6,815 (1,520)	5,095 (1,190)	1,710 (325)	10 (5)	4,500 (880)	3,000 (600)	1,500 (280)	Negl. (Negl.)	2,315 (635)	2,095 (590)	210 (45)	10 (5)
1966	8,020 (1,795)	6,190 (1,450)	1,830 (345)	Negl. (Negl.)	5,500 (1,075)	3,700 (740)	1,800 (335)	Negl. (Negl.)	2,520 (720)	2,490 (710)	30 (10)	Negl. (Negl.)

Thousand Metric Tons

Year	Supply				Production b/				Imports c/			
	Total	Nitrogen	Phosphorus	Potassium	Total	Nitrogen	Phosphorus	Potassium	Total	Nitrogen	Phosphorus	Potassium
1967	8,285 (1,935)	6,830 (1,650)	1,425 (270)	30 (15)	4,000 (780)	2,600 (520)	1,400 (260)	Negl. (Negl.)	4,280 (1,155)	4,230 (1,130)	25 (10)	30 (15)
1968	8,800 (2,175)	7,140 (1,845)	1,620 (310)	35 (20)	4,800 (940)	3,200 (640)	1,600 (300)	Negl. (Negl.)	4,000 (1,235)	3,940 (1,205)	20 (10)	35 (20)
1969	9,920 (2,450)	9,095 (2,105)	1,810 (340)	15 (10)	5,800 (1,135)	4,000 (800)	1,800 (335)	Negl. (Negl.)	4,120 (1,315)	4,095 (1,305)	10 (5)	15 (10)
1970	11,720 (2,945)	9,385 (2,505)	2,305 (430)	30 (15)	7,420 (1,460)	5,100 (1,020)	2,300 (430)	20 (10)	4,300 (1,485)	4,285 (1,480)	5 (Negl.)	10 (5)
1971 d/	13,950 (3,385)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	9,650 (1,900)	6,400 (1,280)	3,200 (600)	50 (20)	4,300 (1,485)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)

a. Data are given in two ways: product weight and actual weight of primary nutrient content -- nitrogen (N), phosphoric acid (P_2O_5), or potassium oxide (K_2O). Nutrient weights are shown in parentheses. Neither domestic production nor imports of raw phosphate rock in any form are included as chemical fertilizer. Except for 1957-58 production data, data are rounded to the nearest 5,000 metric tons.

b. Product weight of various types of domestic chemical fertilizer are converted to Chinese "standard fertilizer units" of fixed nutrient content: nitrogen fertilizers in terms of 20% N, phosphorus fertilizers of 18.7% P_2O_5, and potassium fertilizer of 40% K_2O. Data for 1957 and 1958 were reported by Communist China.

c. Product weight data are aggregate net shipping weight (excluding bagging materials) of all types and grades of imported chemical fertilizer.

d. Preliminary estimates.